

chamber 263, RF power activation/deactivation times, RF power on/off duration, operating frequency, and so forth.

[0051] In particular embodiments, integrated circuit fabrication chamber 263 may comprise input ports in addition to input ports 267 (additional input ports not shown in Figure 2). Accordingly, integrated circuit fabrication chamber 263 may utilize 8 RF input ports. In particular embodiments, process stations ~~251-254~~263 of integrated circuit fabrication chamber 165 may each utilize first and second input ports in which a first input port may convey a signal having a first frequency and in which a second input port may convey a signal having a second frequency. Use of dual frequencies may bring about enhanced plasma characteristics, which may give rise to deposition rates within particular limits and/or more easily controlled deposition rates. Dual frequencies may bring about other desirable consequences, and claimed subject matter is not limited in this respect. In certain embodiments, frequencies of between about 300 kHz and about 65 MHz may be utilized. In some implementations, signal frequencies of about 2 MHz or less may be referred to as low frequency (LF) while frequencies greater than about 2 MHz may be referred to as high frequency (HF).

[0052] Figure 3 depicts a schematic view of an embodiment of a multi-station fabrication chamber wherein an imbalance may be introduced into one or more stations, according to an embodiment 300. In this context, an imbalance may comprise a deviation from a condition in which substantially equal power is coupled to an input port of a process station of a multi-station fabrication chamber to a condition in which an unequal amount of power is coupled to the input port of the process station. In particular embodiments, a balanced condition refers to a condition in which there is less than about a 1% deviation in RF power coupled to each process station. Accordingly, in such embodiments, an imbalanced condition refers to a condition in which there is greater than about a 1% deviation in RF power coupled to each process station. In certain embodiments, a balanced condition refers to a condition in which there is less than about a 2% deviation in RF power coupled to each process station. Accordingly, in such embodiments, an imbalanced condition refers to a condition in which there is greater than about a 2% deviation in RF power coupled to each process station. In other embodiments, a balanced condition refers to a condition in which there is less than about a 2.5% deviation in RF power coupled to each process station. Accordingly, in such embodiments, an imbalanced condition refers to a condition in which

[0063] In particular embodiments, identifying station-to-station nonuniformity in a process condition and/or process result, such as described in reference to 410, may be utilized as an input signal to a feedback loop. Identification of a nonuniformity may, without user input (e.g., automatically), bring about an imbalance in RF power delivered to the individual process stations at which the nonuniformity occurs. Input signals to such a feedback loop may utilize various techniques to measure a non-uniformity among process stations, and such techniques may be employed within a chamber during processing. Techniques employed within a chamber during a fabrication process may include, for example, measurement of precursor or reagent gas concentration, gas temperature etc. Techniques utilized outside of a reaction chamber, which may be employed after completion of wafer processing, may include measurement of the weight of a wafer, wafer topological feature measurements (e.g., critical dimension, etch profile, deposit conformation, deposition film thickness, and so forth), physical and/or chemical properties of a processed wafer, etch rate, etch depth, and electrical and/or optical properties of the wafer (e.g., sheet resistance, breakdown voltage, dielectric constant, refractive index, reflectance spectrum, etc.). These measurements, and potentially others, may be made with an integrated tool such as an integrated metrology module that may be served by infrastructure (e.g., robots) that attend to the process chambers. The measurements may also be made by a non-integrated metrology tool.

[0064] Differences in measured properties of a wafer may be provided as input parameters to a model or other process logic that processes the input parameters and returns output parameters that specify the precise manner of adjustment in, for example, amplitude, frequency content, etc., of RF power to be coupled to individual stations of a multi-chamber station integrated circuit fabrication chamber. Such modifications in characteristics of RF power coupled to the chamber may bring about a reduction in station-to-station non-uniformity. Adjustments may be made iteratively, such as over multiple cycles of processing multiple wafers. Updated determinations in station-to-station nonuniformity levels may be provided to the model or to other process logic, which may be utilized to further update or modify station-to-station RF power levels based on the model output. In some instances, a model may incorporate a relationship between a processed wafer parameter value (e.g., thickness or breakdown voltage) and a corresponding RF power level. In certain embodiments, a model may incorporate one or more sensitivity

from Figure 5 that adjustments in capacitive reactance of an RCC module, such as RCC module 324 coupled to process station 1 (Stn-1), appears to have only a negligible impact on film deposition rates occurring in the remaining ~~chambers~~stations of a fabrication chamber. For example, adjustment in a capacitive reactance at RCC module 324 from about 50% of a maximum value to about 35% of the maximum value decreases the film deposition rate at process station ~~21~~ (Stn-1) by an amount of about 5 Å/min (about 0.33%).

[0067] Figure 6 is a graph showing etch rate of a semiconductor material under a RF power balanced condition and under a RF power imbalanced condition, according to an embodiment 600. The apparatus of Figure 3 may be suitable for performing an etching process resulting in the graph of Figure 6, although etching processes may be performed utilizing other arrangements of equipment, and claimed subject matter is not limited in this respect. The vertical axis of the graph of Figure 6 indicates the wet etch rate, such as may occur during a wet etch process utilizing a 100:1 mixture of hydrogen fluoride (HF) in water in the presence of a time-varying electromagnetic field. In the example of Figure 6, under RF balanced conditions, the wet etch rate taking place at process station 3 (Stn-3) is depicted as occurring at a rate of 139 Å/min while the wet etch rate occurring at process stations 1, 2, and 4 (Stn-1, Stn-2, Stn-4) are depicted as comprising values of 152 Å/min, 158 Å/min, and 144 Å/min, respectively. Thus, referring to the equipment arrangement of Figure 3, although RF power distribution network 323 may be configured to deliver substantially equal allocations of RF power to a multi-station integrated circuit fabrication chamber, variations within individual process chambers may nonetheless bring about nonuniformities in actual in-chamber reaction rates. Utilizing the arrangement of Figure 3, delivery of substantially equal or balanced allocation of RF power among process stations 1-4 may be brought about by adjusting one or more capacitive elements of RCC modules 324-330 to a nominal or baseline value of about 50% of a maximum value.

[0068] In response to detection of a reduced etching rate occurring at station 3 of a multi-station fabrication chamber, a capacitive reactance of RCC module 328 of Figure 3 may be adjusted (e.g., increased), such as from a baseline value of about 50% of a maximum value to about 90% of the maximum value. It should be noted, however, that in particular instances adjustments in capacitive reactance of an RCC module may not bring about a desired increase or decrease in a wet etch rate occurring at a particular process station in relation to the remaining process stations. Thus, in the example of Figure 6, rather than

CLAIMS

~~What is claimed is:~~

1. An apparatus to generate radio frequency (RF) power, comprising:
5 one or more RF power sources; and
a RF power distribution network configured to allocate power from the one or more RF power sources to individual input ports of a multi-station integrated circuit fabrication chamber,
the RF power distribution network additionally configured to apply one or more
10 control parameters to bring about an imbalance in the power from the RF power distribution network to the individual input ports of the multi-station integrated circuit fabrication chamber.
2. The apparatus of claim 1, wherein the RF power distribution network comprises
15 one or more reactive circuit elements.
3. The apparatus of claim 2, further comprising a controller to adjust at least one value of the one or more reactive circuit elements responsive to identification of a
disparity between a process condition and/or a process result at a first station of the multi-
20 station integrated circuit fabrication chamber and a process condition and/or process result at a second station of the multi-station integrated circuit fabrication chamber.
4. The apparatus of claim 3, wherein the process condition and/or the process
result at the first station and the second station comprises a deposition process.
25
5. The apparatus of claim 4, wherein the deposition process comprises atomic layer deposition (ALD).
6. The apparatus of claim 4, wherein the deposition process comprises plasma-
30 enhanced chemical vapor deposition (PECVD).
7. The apparatus of claim 3, wherein the process condition and/or the process result at the first station and the second station comprises an etching process.

8. The apparatus of claim 2, wherein the one or more reactive circuit elements comprises at least one capacitor or at least one inductor.

5 9. The apparatus of claim 8, wherein the one or more reactive circuit elements comprises at least one capacitor, and wherein the one or more control parameters brings about modification of a value of the at least one capacitor to between about 10% and about 90% of a maximum value.

10 10. A multi-station integrated circuit fabrication chamber, comprising:
one or more input ports each configured to receive a signal from one or more radio frequency (RF) power sources;
a RF power distribution network, coupled to a corresponding one of the one or more input ports, the RF power distribution network comprising one or more reactive circuit elements; and
15 a controller coupled to the RF power distribution network and configured to modify a value of the one or more reactive circuit elements to give rise to an imbalance in RF power coupled from the one or more RF power sources to the multi-station integrated circuit fabrication chamber.

20 11. The multi-station integrated circuit fabrication chamber of claim 10, wherein the one or more reactive circuit elements comprises one or more capacitors.

25 12. The multi-station integrated circuit fabrication chamber of claim 11, wherein the controller is configured to modify a value of capacitance of the one or more capacitors from between about 10% of a maximum value to about 90% of ~~a~~the maximum value.

30 13. The multi-station integrated circuit fabrication chamber of claim 10, wherein the controller is configured to modify the value of the one or more reactive circuit elements responsive to identification of a difference between a process condition and/or a process result at a first station of the multi-station integrated circuit fabrication chamber and a process condition and/or a process result at a second station of the multi-station integrated circuit fabrication chamber.

14. The multi-station integrated circuit fabrication chamber of claim 13, wherein the process condition and/or the process result at the first station and the second station comprises a deposition process.

5 15. The multi-station integrated circuit fabrication chamber of claim 13, wherein the process condition and/or the process result at the first station and the second station comprises an etching process.

10 16. The multi-station integrated circuit fabrication chamber of claim 10, wherein the multi-station integrated circuit fabrication chamber comprises 4 process stations.

17. The multi-station integrated circuit fabrication chamber of claim 10, wherein the multi-station integrated circuit fabrication chamber comprises 2 process stations.

15 18. The multi-station integrated circuit fabrication chamber of claim 10, wherein the multi-station integrated circuit fabrication chamber comprises 8 process stations.

19. The multi-station integrated circuit fabrication chamber of claim 10, wherein the multi-station integrated circuit fabrication chamber comprises 16 process stations.

20

20. A control module, comprising:

a hardware processor coupled to a memory; and

a communications port configured to:

receive an indication that a process condition and/or a process result at a first

25 station of a multi-station integrated circuit fabrication chamber is different than a process condition and/or a process result at a second station of the multi-station integrated circuit fabrication chamber; and

transmit one or more instructions to a RF power distribution network to bring

about an imbalance in radio frequency (RF) power coupled to the first station of the multi-
30 station integrated circuit fabrication chamber with respect to the RF power coupled to the second station of the multi-station integrated circuit fabrication chamber.

21. The control module of claim 20, wherein the one or more instructions operate to modify a value of one or more reactive elements of the RF power distribution network.

22. The control module of claim 21, wherein the one or more reactive elements comprise at least one capacitor, and wherein the one or more instructions operates to modify the value of the at least one capacitor to between about 10% and about 90% of a maximum value.

23. A method for controlling a fabrication process, comprising:
identifying that a process condition and/or a process result at a first station of a multi-station integrated circuit fabrication chamber is different than a process condition and/or a process result at a second station of the multi-station integrated circuit fabrication chamber; and

imbalancing radio frequency (RF) power coupled to the first station of the multi-station integrated circuit fabrication chamber with respect to the RF power coupled to the second station of the multi-station integrated circuit fabrication chamber.

24. The method of claim 23, wherein imbalancing comprises modifying a value of a reactive circuit element of RF power distribution network coupled to an input port of the multi-station integrated circuit fabrication chamber.

25. The method of claim 24, wherein modifying the value of the reactive circuit element comprises adjusting capacitance of the reactive circuit element from a nominal value of about 50% of a maximum value of capacitance to a value of between about 10% and about 90% of the maximum value of capacitance.

26. The method of claim 23, wherein imbalancing comprises generating at least about a 1% difference between RF power coupled to the first station of the multi-station integrated circuit fabrication chamber with respect to the second station of the multi-station integrated circuit fabrication chamber.

27. The method of claim 23, wherein the process condition and/or the process result at the first station and the second station comprises a deposition process.

28. The method of claim 23, wherein the process condition and/or the process result at the first station and the second station comprises an etching process.